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Survivor Math: Using Pop Culture to Enhance Learning Mathematics

Robert Burks

Abstract: This article describes a modification of the popular TV game show, *Survivor*, as conducted in an undergraduate first semester mathematics precalculus course. The objective of this game is a group-based competitive drill and practice activity to help students prepare and review for the fundamental concepts exam. The results of this activity include: increased understanding of the fundamental concepts, increased confidence for the fundamental concepts exam, and increased preparedness for the mathematics concepts presented in future mathematics, science, and engineering courses, and increased communication skills.

Keywords: Precalculus, skill development, mathematics activity, group based competition.

1. INTRODUCTION

Many students enter West Point with an educational background that focused on traditional, lecture-based instruction. This teacher-centered approach places emphasis on the lecturer's responsibility of providing information and the student's role as a passive learner. However, at West Point, one objective of our core mathematics program is to provide a more student-centered learning environment designed to make students more responsible for their education. Over the years, a variety of non-traditional instruction methods have been developed to counter the teacher-centered approach and encourage student participation [1–4]. A key feature of these methods is the desire to engage the student in the learning process, despite student reluctance in some cases. One non-traditional method for engaging students is group-based competitive exercises.

Competition may be defined as "the act of competing," "a contest between rivals" [5], or as " a social process that occurs when rewards are given to people on the basis of how their performances compare with the performances of

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others doing the same task or participating in the same event" [6]. However, no matter how you define it, competition is a common occurrence in the daily routine of most college students and bringing competition into the classroom represents a natural extension of these experiences. Competition, by itself, is neither inherently good nor bad in supporting the learning process. Its true value in enhancing the learning process is dependent on how an instructor employs this non-traditional strategy in their classroom. Competition, if correctly applied, can provide an effective method to engage students and support a more student-centered learning environment [7–9].

Over the years instructors in the mathematics department have developed several non-traditional activities based on pop TV culture, including *Weakest Link*, and *Mathematical Idol* [10], to help students review and prepare for their respective courses. These activities were not only well-received by our students, but do a very nice job of preparing our students for the mathematics concepts presented in the school's core mathematics and science curriculum.

The competition described in this article is based on a reality game show popular among our students, *Survivor*. In this show, 16 complete strangers are brought together in a remote hostile environment, ranging from the open plains of Kenya's Shaba National Reserve in Africa to the jungles of Brazil, and are forced to compete and survive for 31 days. Initially contestants are divided into teams (tribes) and are required to cooperate as a group in an effort to complete challenges and avoid elimination from the game. In the end, contestants attempt to outwit, outplay, and outlast each other to become the sole survivor. At the end of the season, the winner receives one million dollars and the recognition of being the sole survivor.

In its basic form, elements of the show represent many of the principals associated with cooperative learning in a competitive environment or group-based competitive activities [4, 11]. This article describes a modified experience of this pop culture icon in a mathematics classroom, *Survivor Math*. *Survivor Math* is designed to take advantage of students' interests outside the classroom to engage them in the learning process. In this version, 16–18 student-contestants are brought together in the mathematics classroom, perceived by many of them as a hostile environment, and are required to work both as a member of a small group and as an individual to solve a series of mathematics problems. The instructor serves as the host, facilitator, and ultimate judge of success. The results of this cooperative competitive activity include: increased awareness of fundamental mathematics concepts, increased confidence to solve problems in a timed environment, and the ability to communicate mathematic concepts to their peers.

2. DEVELOPING A BODY OF KNOWLEDGE

The study of mathematics, science, and computational methods as part of the school's core curriculum is designed to establish fundamental scientific literacy

and a propensity for rational thought in our students. This study is structured to facilitate progressive intellectual growth in the student as he or she progress through the core curriculum. This sequential acquisition of a body of knowledge is built upon a foundation consisting of a firm understanding and mastery of precalculus material taught in high school. To reinforce this understanding, West Point has identified a set of precalculus mathematics skills and concepts that all students must possess in order to understand the concepts presented in the core curriculum [12]. Our experience has shown that students who lack a solid understanding of these concepts or who are not able to readily recall these concepts tend to struggle in the mathematics classroom.

In order to assess student knowledge of these fundamental skills and concepts, the Department of Mathematical Sciences administers a Fundamental Concepts Exam (FCE), called the "Gateway" exam, to every freshman student prior to the start of the school year. This FCE typically consists of 30 questions designed to assess a student's understanding of the desired fundamental concepts. Students have 55 minutes to complete the exam, without the aid of a calculator or notes, and must earn an 80% or better on the exam for consideration of advancement beyond their first semester mathematics course.

The events described in this article occurred during a semester-long precalculus mathematics course consisting of college freshmen who failed the Gateway exam and needed additional instruction in the fundamental concepts. The course is comprised of 64 class meetings consisting of 56 lessons and 8 problem solving labs. *Survivor Math*, while designed to reinforce fundamental precalculus concepts, is easily transferable to any course that uses "benchmark" tests or quizzes. Lists of fundamental concepts similar to the one for precalculus provided in this article could be created for many different mathematics settings and would provide ideal settings for this type of game.

3. OBJECTIVES OF THE COMPETITION

Many of the students in the course start the semester with a fear or dislike of mathematics and little confidence in their abilities to do well in the course. To overcome these conditions, one of the main objectives of the game is to motivate learning by encouraging the student to become more engaged in his or her own learning process. This engagement is designed to specifically reinforce understanding of the required fundamental mathematics concepts and instill confidence in the student's mathematics ability. I also wanted to place the student in a dynamic/active situation to demonstrate that they could respond under pressure. This situation increases student confidence in their ability to solve problems under time pressure and eases their fears of the timed exam. My last objective was a desire to increase the mathematics communication skills of my students by having them present selected solutions to the class.

I also recognized that all of my students enter the course with their own set of objectives. Many of my students do not want to be in a mathematics class;

in fact approximately 50% of them will seek a liberal arts major and would be perfectly content to never take a mathematics class. A review of motivation literature suggests that most learners are classified into one of three groups based on the way they approach learning; deep learners, strategic learners, and performance avoiders [13]. Deep learners are intrinsically motivated and approach learning with a zeal. Strategic learners are concerned with the moment and generally want good grades. Performance avoiders represent the final group [14, p. 40]. These individuals are surface learners who are really afraid of leaving their comfort zone or stepping out to try something new [14]. Regardless of their personal objectives all students will gladly seek to gain as many "bonus points" as possible. I take advantage of this fact be providing an opportunity for all students to earn bonus points during the course of the game.

4. *SURVIVOR MATH*—THE SETUP

Survivor Math is designed as a semester-long competition to help students review, learn, use, and master the material covered by the various FCE categories. The following section describes the competition which culminated with the announcement of a winner at the end of the semester.

During the first couple days of the semester, as I covered typical course administrative information, I told the students that they would be challenged by many non-traditional teaching methods including *Survivor Math.* The winner of the competition would be announced on the last day of the semester and that individual would be recognized as the sole survivor or the ultimate "Mathlete."[1] The title of sole survivor is awarded to the student with the highest combined score based on several performance criteria. These criteria include:

- performance on the final FCE
- most improved FCE grade
- performance during the individual episodes (in class competitions)
- "Fan Favorite"

The first three categories are determined by student performance during the course, based on both individual and group classroom events, and the last category is subjective based on student feedback. Performance on the final FCE, which was administered during the 17th week of the course, is based on the student's actual FCE grade.

[1]The neologism "Mathlete" was first coined in a 1933 *New York Times* sports article, "Army 'Mathletes' Defeat Harvard, 98–112," describing Army's victory over Harvard in a mathematics competition. This contest was expanded in 1938 to become the national Putnam Competition [15]. The term "Mathlete" is still used today in the department to refer to individuals achieving a superior level of mathematics excellence.

I rank ordered the class roster from lowest to highest FCE grade and assigned a number from 1 to "*n*" to each student. This number represents the number of points earned by the student. The most improved FCE grade captures the change in grade from the student's Gateway score and their final FCE grade (Δ = *FCE Grade* − *Gateway Score*). The idea is to reward the largest positive improvement in the FCE. I rank ordered students from lowest to highest change in score and assigned a number from 1 to "*n*" to each student. Again, this number represents the number of points earned by the student. The performance during the individual episodes is a summation of points awarded during the *Survivor Math* episodes conducted in the classroom. These points, discussed later, are simply added to a student's combined score.

The last category, "Fan Favorite," is where the students themselves provide feedback to the instructor. After each episode, students list on an index card the name of a fellow student who had provided the most help in their gaining a better understanding of the fundamental concepts. Throughout the semester, I maintained a tally of votes for each name identified. At the end of the semester, the number of votes received was the number of points awarded to a student. The ultimate survivor was the student with the highest combined score from all four performance areas.

4.1. Preparation

Implementation of this activity requires a little pre-class logistics and administration. This activity is intended to be given as an individual/group exercise with minimal assistance from the instructor. Experience shows that breaking the class into groups (tribes) of three students works best (my class size is usually about 15–18 students). The small group size is important as it allows for needed peer-to-peer interaction and allows everyone to participate in the activity. I have had success both with letting the students select their tribe mates and with pre-selecting the groups. When pre-selecting the groups, I typically match stronger students with weaker students. Also, in keeping with the chaotic nature of the actual show, I typically scramble the groups after the second competition.

4.1.1. Preparation – Questions

As a drill and practice activity, *Survivor Math* requires a set of questions (challenges) the students will encounter during the activity. During a typical episode, the students will generally answer anywhere from 20 to 30 questions depending on how many times they have been exposed to the experience and the objective for the activity. *Survivor Math* consists of three types of questions; individual, reward, and group. Depending on when an instructor plans to implement this activity in the course determines the mix of individual and group questions. Introducing the activity early in the course lends itself to more group

questions as opposed to individual questions. However, if the activity represents a capstone event just prior to the actual FCE then there should be more individual questions. Reward questions are really independent of implementation time. These questions are designed to increase/sustain the fun, energy of the students, and competitive atmosphere of the activity. On average, a single 30 question episode typically consisted of approximately 60% (18) individual questions, 30% (9) group questions, and 10% (3) reward questions.

Individual questions represent topic areas or concepts students should have mastered prior to the activity. Students should be able to rapidly recall the concepts necessary to solve the question. As an example, by the seventh week of the course, we have covered and extensively practiced solving logarithmic functions and equations. As a result, I would expect students to have the ability to rapidly answer the following individual question:

Challenge X: Simplify the following expression: $\log_5(49) - \log_5(7)$

The objective of the individual question is for the student to completely work out the solution, showing all work, in the allotted time. Remember, the objective for this question is rapid recall without effort but I require a complete solution.

Group questions cover material that has been reviewed and practiced but may not be completely mastered by the student. Allowing group work on these type questions allows for peer-to-peer teaching and learning, while reinforcing the required concepts. To ensure maximum participation, a group question might be structured to force some level of involvement from each member of the group. I tend to do this later in the semester after students have become more comfortable in their environment.

I have used several approaches to get at maximum participation, including requiring the first team member to solve the question and then requiring the other team members to review and certify that the solution is correct. I have also had success requiring each member of the team to participate in solving a portion of the problem. The following is one example of this approach for a group challenge:

Challenge X: Simplify the following expression: $(\sqrt[5]{x^2})(\sqrt[3]{x^4})$

Team Member 1: Rewrite the expression as Rational Exponents.
Team Member 2: Simply using the Laws of Exponents.
Team Member 3: Review and Certify the solution.

I also place a requirement on the groups that the same individual cannot perform the same task for consecutive questions. This requirement helps ensure that all players remain actively involved in the game. The objective of the group question is for the group of students to work together to completely work out

the solution, showing all work, in the allotted time. The group as a whole is evaluated on the correctness of the entire problem.

Reward questions represent the final category of questions and have an associated level of difficulty somewhere between individual and group questions. A reward question, as the name implies, has some sort of reward associated with answering the question. I have found that chocolate and cookies tend to serve as the most enticing reward for students. As opposed to either individual or group questions, the objective of a reward question is rapid recall and increasing the level of excitement for the game. Therefore, the winner is the first individual who correctly answers the question.

4.1.2. Preparation– Building Atmosphere

To increase motivation and help set the atmosphere for the competition, I developed a short introduction movie, e.g., opening credits, to start the episode (class). A review of the opening credits for any of the 18 *Survivor* seasons will provide a general idea for the concept of my opening credits [16]. I used the opening credits to start the activity, capture student imagination, set the atmosphere for the activity, and serve as a nice link to the actual show. The actual movie I developed runs approximately 90 seconds and is a compilation of actual *Survivor* scenery footage and theme song, and photos of my students. I used both a "mug shot" of the student (from their student ID) and action photos of common student activities in the credits.

Developing the opening credits is not as daunting as it initially sounds and I believe anyone with some computer skills can construct the film. The *Survivor* clips and theme song are readily available for download from CBS Broadcasting Inc. (CBS) [16]. The movie editing software is nothing fancier than Microsoft Windows Movie Maker which is readily available to any individual using Windows XP. The most difficult part of the production process was actually capturing photos of my students. Once I had each of the components, the actual film production time was approximately 30–40 minutes per classroom. I thought about creating a single generic version that I could use each year but I found that my students greatly appreciated the personal touch of having their own movie.

The final pre-activity step was preparing the classroom for the activity. I found that bringing in a couple of simple Halloween flaming skulls and other similar props adds a nice touch for both the *Survivor* and Skull Island theme of the activity. With all elements in place, I was now ready for my students.

5. PLAYING THE GAME

Prelude: *You have been selected to participate in West Point's newest reality show, Survivor Math, where only the quick-witted and nimblest of minds have*

any hope of surviving to become the ultimate Mathlete. Tomorrow you will face many challenges, both as an individual and as a member of your tribe. If you survive the challenge (answer the problem correctly), then you or your tribe will remain standing. However, if you fail the challenge (answer the question incorrectly) then you will be exiled to Skull Island to face the next challenge. You will remain on Skull Island until you accomplish a challenge, at which time you may return to the chalkboard. Do you have what it takes to become the next Survivor Math Mathlete?

Typically, the above prelude information and my *Survivor Math* logo (Figure 1) are e-mailed to the students the night before the activity is scheduled with the message that the only items they need to bring to class are their quick wit and keen mind.

After viewing the opening credits, I divide all students into their tribes (groups) and have them stand at their respective chalkboards. The first challenge (question) is presented and we begin the episode. I usually place a time limit on the amount of time students have to answer any particular question. Generally, for individual questions, the time limit is less than the average per question time available on the actual FCE (approximately two minutes). This places a little stress on the students and helps prepare them mentally for the actual test.

Once the individual or group question is presented, students solve the problem showing all work. Showing work, not just providing a solution, is critical to reinforce the concept and to help those students who have not mastered the concept. If it appears that many of the students missed the problem, I will select one student to explain to the class how he or she solved the problem. This presentation serves two purposes:

1. it allows the weaker students to see how to solve the problem, and
2. it allows the presenter to practice oral mathematics communication skills.

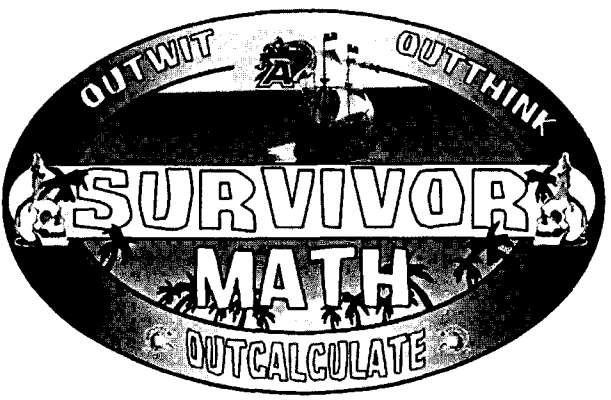

Figure 1.

The only exception to showing work is for the reward challenge where the drive to be the first to answer the question is the goal.

Students who answer an individual or group challenge correctly remain standing at the board and are awarded one point toward their combined sole survivor score. However, students who answer the question incorrectly sit down at their desk (Skull Island), where they are required to work the next challenge from their desk and on paper. A student will remain on Skull Island until he or she correctly answers a challenge. I do not require all members of a group to answer a question correctly for the group to get off Skull Island. Individual members of a group will return to the chalkboard after answering a question. However, points are only awarded to members of a group who are standing.

I will typically continue the process of presenting challenges until class time (55 minutes) expires or I have met my objectives for the episode. As an additional incentive, every individual still standing (not on Skull Island) at the end of the activity is rewarded. This reward is instructor-dependent, but I have had a great deal of success using bonus points for individuals still standing. I have found that the use of bonus points provides a more extrinsic motivation to those students who were not motivated by the survivor competition. This incentive provides the additional benefit of having students only competing against themselves for a reward with actual consequences to their course grade. In this situation, it is possible for every student to benefit even if they do not win the *Survivor Math* competition.

6. RESULTS

The first time this activity is introduced to the students they do not know what to expect. I have found that most students are familiar with the popular reality TV show, currently in its 18th season, and enter the classroom with some anticipation. After showing the opening credits for the first time, I have actually received applause from the class and an increased excitement about the activity. There is some initial hesitation among the weaker students in the class who do not believe they have a chance at winning until they realize that they are really competing against themselves for the bonus points. The spirit of competition typically takes hold after a few questions and especially with the introduction of the first reward challenge. It is amazing how much a little chocolate motivates a college student!

After several challenges pass, I typically have to rein in the students as they begin taking shortcuts, in working the problem, to be the first one to answer a question. At this point, I simply remind them that the objective is to correctly answer the question and not rush to be the first to complete the problem. In my experience, the activity will cover 25–30 problems during the class period. If these questions are structured correctly, this activity represents an actual FCE and the students do not even realize it. Students have expressed more confidence entering the FCE after this activity and the combination of

time pressure and confidence gained from working the problems relieves some of the pre-test anxiety of the actual exam.

This activity engaged students and provided a nice relief from the traditional classroom drill exercises. The activity was quite challenging to ill-prepared students and definitely uncovered weaknesses in their topic preparation. Student feedback gathered during the semester told me that:

- 78.57% (22 of 28) thought winning the competition was important,
- 85.71% (24 of 28) thought the competition promoted learning the fundamental concepts,
- 71.43% (20 of 28) felt that the interaction with other students during the competition increased their knowledge of the fundamental skills, and
- 78.57% (22 of 28) felt better prepared entering the final FCE.

From my perspective, I noticed with each of the four in-class competitions more students became involved with the activity. I also noticed that those students who hesitated to answer questions in class displayed more confidence in their ability to answer a question during the game.

7. CONCLUSION

The activity was generally well received by the students. Many students loved that the activity helped reinforce their understanding of the required concepts and prepared them for the exam. Most students felt that the introduction of a time requirement to answer the question was a nice reminder of the actual exam pressure. Many liked the additional effort taken to set up the experience for them and saw it as a welcome break. In the end, we all learned something, we had fun, and we ate chocolate. Who could ask for more from a mathematics course? I would encourage you to consider this activity for your students.

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BIOGRAPHICAL SKETCH

Robert Burks graduated from the United States Military Academy in 1987 with a B.S. in Aerospace Engineering. He later received a M.S. in Operations Research from the Florida Institute of Technology, and a Ph.D. in Operations Research from the Air Force Institute of Technology. He served as an Assistant Professor in the Department of Mathematical Sciences at the United States Military Academy and is the Program Director for the Department's Developmental Mathematics program for this implementation. He is currently the Associate Dean for the Graduate School of Operational and Information Sciences at the Naval Postgraduate School.